

Department of
Conservation and Recreation



Origin / Destination
Survey Results

July 2006

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Engineers • Scientists • Planners

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TECHNICAL MEMORANDUM

REHABILITATION OF STORROW DRIVE TUNNELS

Boston, Massachusetts

ORIGIN/DESTINATION SURVEY RESULTS

Prepared for

The Department of Conservation and Recreation

July, 2006

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Introduction

The Department of Conservation and Recreation (DCR) has determined that the Storror Drive Tunnels between Clarendon and Arlington Streets have deteriorated after 55 years of use and are in need of repair. Several options for bridge repair and associated staging and traffic management are being considered. Construction may result in partial and temporary shutdowns on Storror Drive. In addition, alternatives for the final alignment of Storror Drive and ramp configurations are being considered.

Critical to making decisions about traffic management schemes and final conditions will be input regarding driver choices. If Storror Drive is shut down for periods, how will motorists whose normal route is unavailable get to their destinations? If the westbound off-ramp to Arlington Street is closed, how will motorists access Back Bay? Must motorists look for new driving options, or are transit options practicable?

DCR recognized the importance of gathering information required to answer these and a variety of other questions. As such, they authorized a comprehensive Origin/Destination (O/D) survey to extract this information from the most direct source – the motorists currently using Storror Drive.

Survey Scope

While the area most affected physically by this project is the section of Storror Drive between Arlington Street and Charlesgate, it is reasonable to assume that the impacts to motorists causing traffic diversions would extend to the Memorial Drive intersection with Greenough Boulevard to the west, and to Leverett Circle to the east. Therefore, the survey was conducted at on- and off-ramps between these locations.

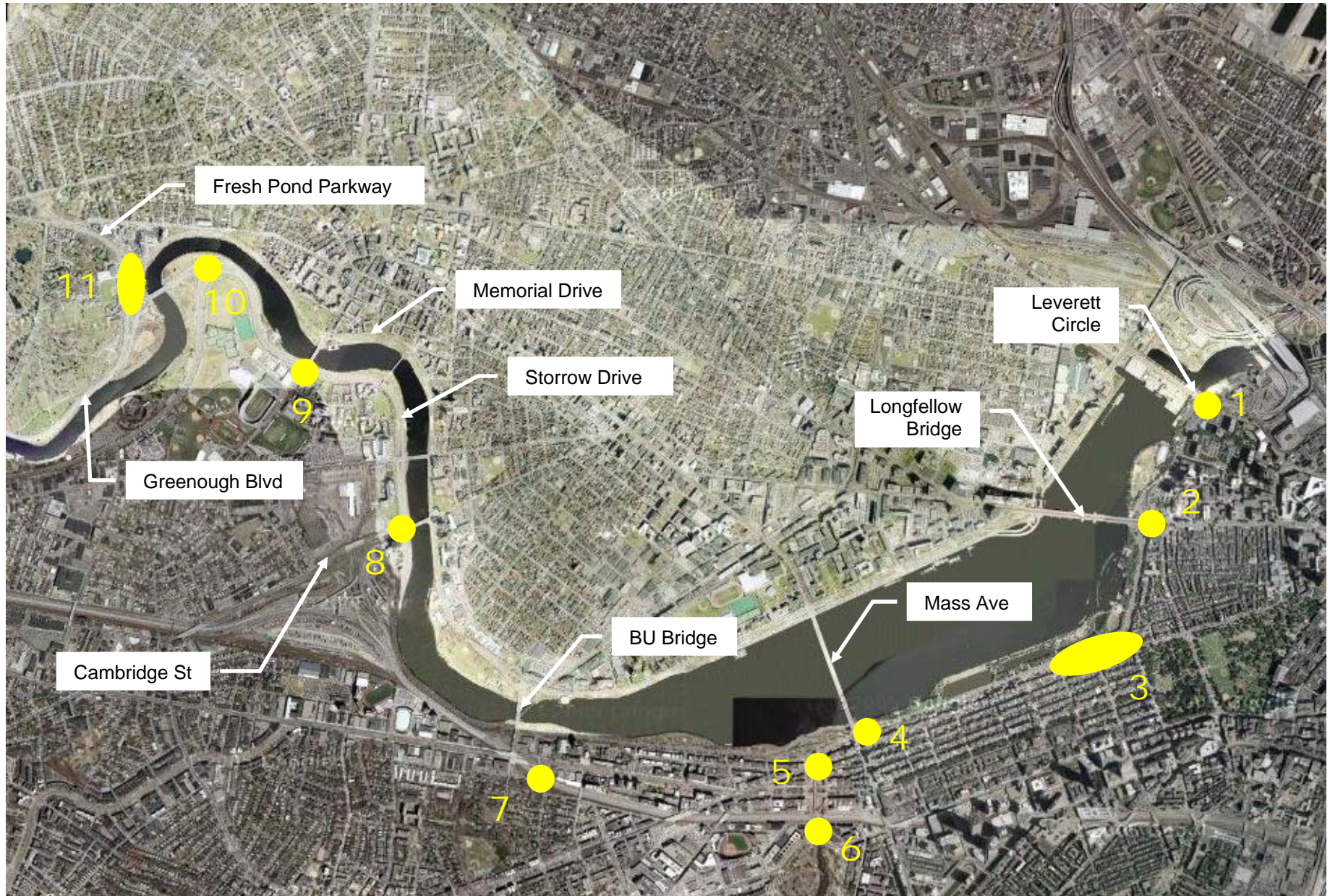
Each survey location was examined in the field to locate areas where surveyors could safely distribute survey forms when vehicles come to a stop. At two locations, including the on-ramp from Soldiers Field Road on the west, and the I-93 move to Storror Drive on the east, it was determined that surveyors could not safely hand out forms because vehicles do not come to a stop. These two locations were the only two ramps at which forms were not distributed. This information was still gathered, however, since all exit ramps were included and the survey forms included questions about both entry ramps and exit ramps to Storror Drive. Ramps included in the survey are summarized in Table 1 and Figure 1.

The survey was conducted on Thursday, April 28, 2006 from 7:00 AM to 7:00 PM.

Table 1 – Survey Locations

STATION	LOCATION	Entrance / Exit	STATION	LOCATION	Entrance / Exit
1) Leverett Circle			7) Storrow Dr Eastbound On-Ramp At Boston University		
1A	O'Brien Highway Right Turn to Storrow Dr.	Entrance	7A	Carlton St Approach to Commonwealth Ave	Entrance
1B	Nashua Street Through Move	Entrance	7B	Commonwealth Ave Westbound Right Turn to Storrow Dr On-Ramp	Entrance
1C	Storrow Drive Westbound Approach to Leverett Circle	Exit	8) River St & I-90 Access		
2) Charles Circle			8A	Soldiers Field Road Westbound Off-Ramp	Exit
2A	Storrow Drive Westbound Off-Ramp	Exit	8B	Western Ave Connector Road Eastbound Through Move	Entrance
2B	Longfellow Bridge Inbound	Entrance	8C	Cambridge St / I-90 Approach to Soldiers Field Road	Entrance
2C	Storrow Drive Eastbound Off-Ramp	Exit	9) North Harvard St		
2D	Cambridge Street	Entrance	9A	Soldiers Field Road Westbound Off-Ramp	Exit
3) Beacon St			9B	North Harvard St Northbound Right Turn	Entrance
3A	Beacon St Right Turn To Storrow Eastbound	Entrance	9C	North Harvard Southbound Left Turn	Entrance
3B	Arlington St Exit From Storrow Dr	Exit	10) Soldiers Field Road		
3C	Beacon St Right Turn to Berkeley St On-Ramp	Entrance	10A	Soldiers Field Road Westbound Left Turn	Exit
3D	Berkeley St Through Move at Beacon St	Entrance	10B	Soldiers Field Road Eastbound Through Move	Entrance
3E	Storrow Dr Off-Ramp at Clarendon St	Exit	11) Soldiers Field Road @ Memorial Drive		
4) Massachusetts Ave			11A	Soldiers Field Road To Alewife Brook Parkway	Exit
4A	Westbound Off-Ramp at Massachusetts Ave	Exit	11B	Soldiers Field Road To Memorial Drive	Exit
5) Beacon St At Charlesgate			11C	Soldiers Field Road To Greenough Parkway	Exit
5A	Charlesgate East Approach to Beacon St	Entrance			
5B	Beacon St Approach to Charlesgate East	Entrance			
5C	Storrow Drive Off-Ramp Approach to Beacon St	Exit			
6) Charlesgate At Boylston St / Fenway					
6A	Charlesgate Approach to Boylston St	Exit			
6B	Boylston St WB Approach to Charlesgate	Entrance			
6C	Boylston St EB Approach to Charlesgate	Entrance			
				Entrances:	18
				Exits:	14
				Total:	32

Figure 1
Survey Locations



Methodology

The development of this survey was accomplished with the following tasks:

1. Needs Identification

The first step in planning this survey was to examine the issues related to impacts of this construction, and to develop an understanding of the needs of motorists during this period. Storrow Drive currently carries in excess of 100,000 vehicles per day, with some ramps, such as the westbound off-ramp to Arlington Street carrying over 12,000 vehicles. These volumes are comparable to portions of the Mass Turnpike and I-93.

It is clear that the project will have impacts and the emphasis must be on minimizing delays through pro-active measures, such as the use of variable message signs to communicate with motorists *in advance* of congested areas. Instead of forcing motorists to deal with unexpected circumstances, appropriate alternative routes should be identified in advance and communicated to motorists before decision points. Another pro-active measure would be to identify public transit opportunities and the possibility of increasing service on commuter rail, subway or bus lines. Remote parking combined with shuttle service is another strategy to be examined.

Before these measures can be evaluated, however, it is necessary to understand current commuter characteristics along Storrow Drive. The questions included on the survey form have been designed to glean the information that can lead to a meaningful evaluation of these strategies.

2. Survey Questionnaire

With consideration to the discussion above, a survey questionnaire was designed to facilitate the motorists' ability to answer questions necessary to develop effective congestion management measures. This self-coding, pre-paid mailback form was developed in draft format and distributed to reviewing agencies and project team members for review. After incorporation of significant comments, the form was finalized. The form is shown in Appendix A, located at the end of this memorandum.

3. Field Review

Survey locations were reviewed for optimum placement of surveyors. The primary concern was for safety of the surveyors. At each location, sidewalks, medians and traffic islands were identified to provide safe zones for the surveyors. Another factor in selection of locations was the presence of traffic signal operation that would allow surveyors to approach vehicles that were stopped at red lights. Another consideration was providing access to motorists without creating vehicle delays.

4. Surveyor Training

A training session was held on Monday, April 24, 2006 to discuss expectations for the survey. Temporary hires were instructed to the following:

- The purpose of the survey
- Safety, including where to stand and how to approach a vehicle
- Safety equipment, including orange vests and rain gear
- Proper attire
- Proper conduct
- Procedures for restocking survey forms
- Duration of the survey
- Distribution policies – no taxis, only one form per vehicle

Statistical Significance

1. Rate of Return

A total of 39,985 forms were distributed and 7,785 were returned, for a return rate of 19.5 percent. This rate of return compares favorably to past experience with this type of O/D survey in which 10-12 percent is often achieved.

Of the 7,785 surveys returned, 59 were returned completely blank. These forms were not included in the data analysis. The number of valid survey forms returned was 7,726.

2. Sample Size Requirements

Required sample size is calculated from the following formula:

$$SS = (\hat{p}(1 - \hat{p})) \times \left(\frac{Z}{E}\right)^2$$

Where:

SS = Sample Size, or the number of responses required to be sure that the answers truly reflect the population.

\hat{p} = Sample Proportion, or the percentage of the sample that have a particular attribute. The worst case is 50%, and that should be used to determine the level of accuracy for a sample.

Z = Z-value (e.g. 1.96 at the 95% confidence level)

E = Margin of Error, or a measure of the variation within the data. The smaller this value is the more uniform the data is.

Confidence level = A percentage representing the how often the true percentage of the population who would pick an answer would lie in the confidence interval. (i.e. 95%)

Confidence interval = This value defines a range of values within which the true population answer would fall. (i.e. +/- 2%)

Assuming a confidence level of 95%, a confidence interval of 5% and a Sample Proportion of 0.5, a sample size of 384 would be required to be sure that each answer truly reflects the population. This number would be required for each possible response. Therefore, with question number 5 on the survey form having 15 possible answers, the total number of responses required would be 384×15 , or 5,760. The total of 7,726 responses that used Storrow Drive therefore insures that each of the responses is reflective of the population for question 5, and therefore each of the multiple choice questions.

Survey Results

1. Summary of each question

- Question 1 – Will this trip include Storrow Drive? This question was included because the survey was distributed at locations where some vehicles could receive a form but not use Storrow Drive on that particular trip. 7,270 (94.1%) motorists responded that they used Storrow Drive during the trip they received the form, and 456 (5.9%) responded that they did not use Storrow Drive.
- Question 2 – Where did you start this trip? – Figure 2 presents the Origin and Destination zones used to group the responses to question 2 and 3. Figures 3, 4 and 5 summarize the data associated with this question. Boston was the most frequently reported origin point with 3,052 trips (42.0%). The next four most frequently reported origins are Central Middlesex County with 999 trips (13.7%), Cambridge with 839 trips (11.5%), Northern Middlesex County with 692 trips (9.5%), and North-East Essex County with 423 trips (5.8%).
- Question 3 – Where did you end this trip? – Figures 6, 7, and 8 summarize the data associated with this question. Boston was the most frequently reported destination point with 4,545 trips (62.5%). The next four most frequently reported destinations are Cambridge with 814 trips (11.2%), Central Middlesex County with 569 trips (7.8%), Northern Middlesex County with 299 trips (4.1%), and Eastern Middlesex County with 243 trips (3.3%).
- Question 4&5 – Were did you enter Storrow Drive? Where did you exit Storrow Drive? The data for questions 4 and 5 are summarized in an Origin - Destination Trip Matrix which can be found in Table 2. The origins are listed along the left side of the table and the destinations are listed across the top. There were 7,075 respondents that provided answers to question 4 and 5, of which 6,295 were feasible. An infeasible combination is one that can not be physically made.

Figure 2
Origin / Destination Zones

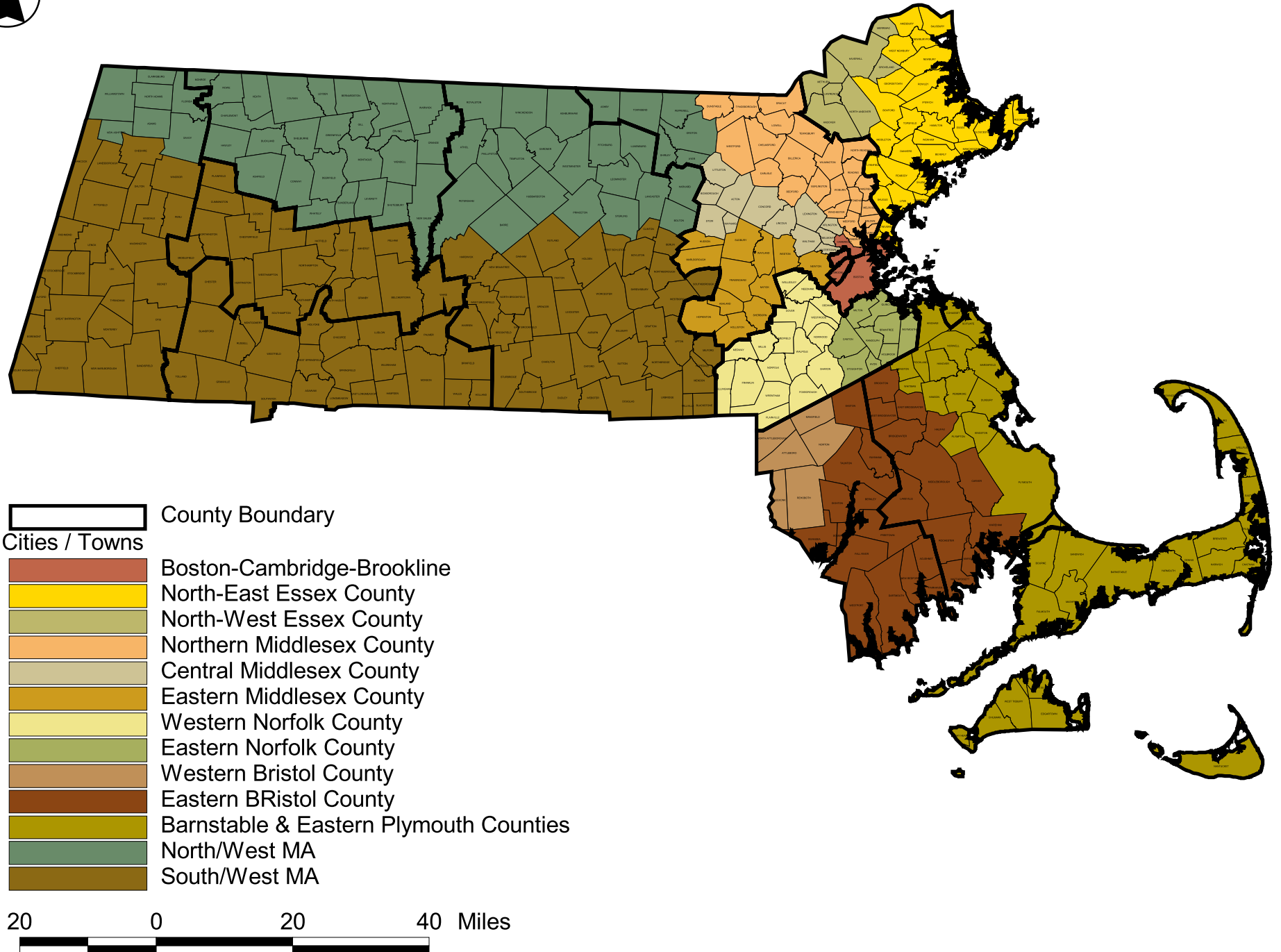


Figure 3 - Trip Origins by City/Town

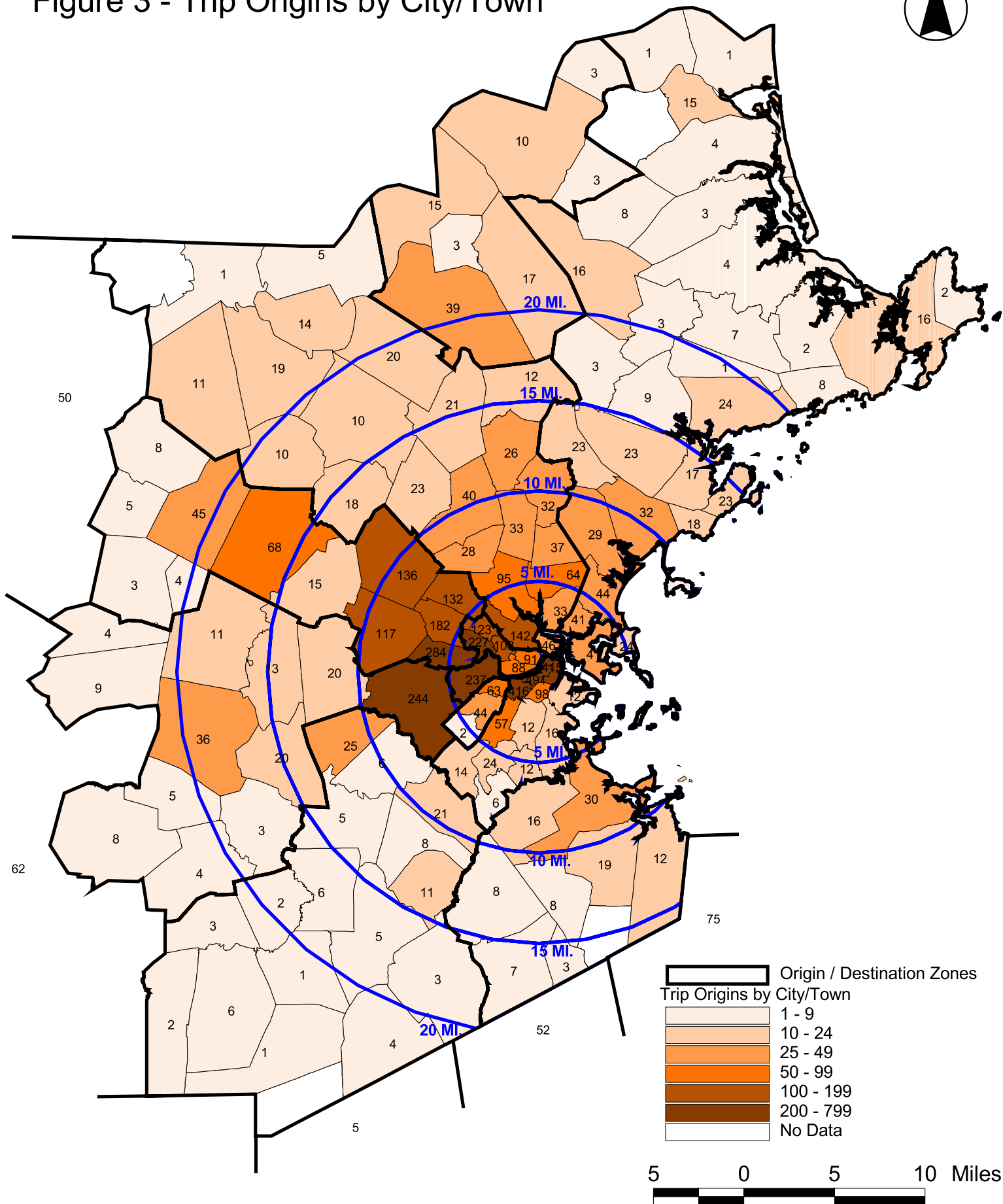


Figure 4
Question 2 – Trip Origin

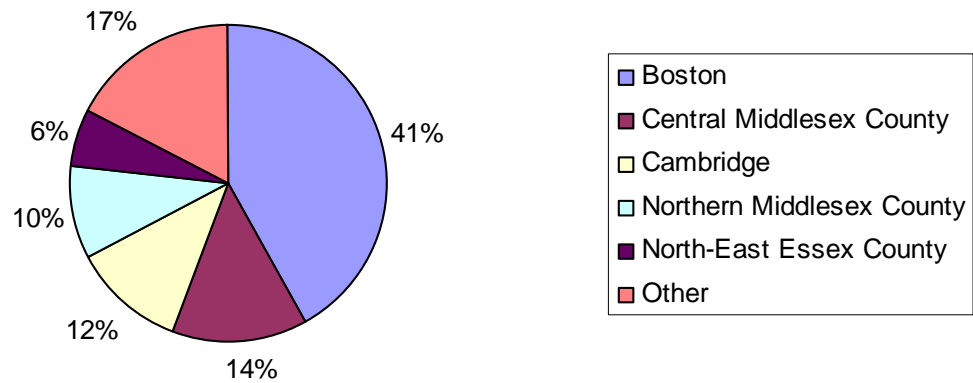


Figure 5
Trip Origins within Boston

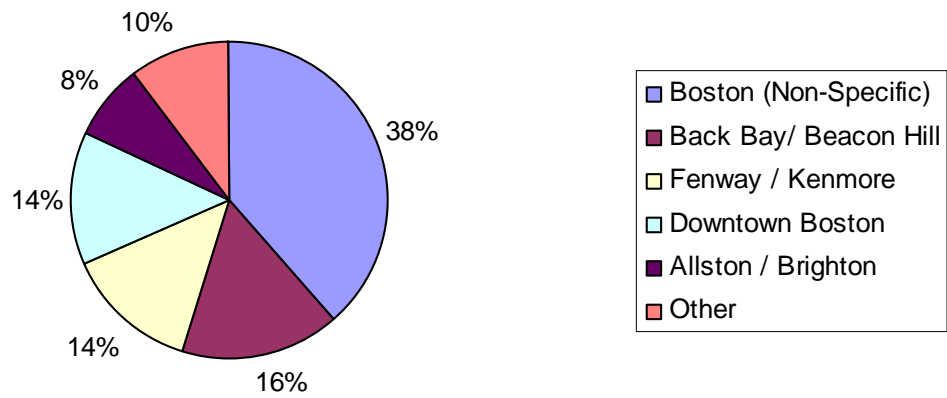


Figure 6 - Trip Destinations by City/Town

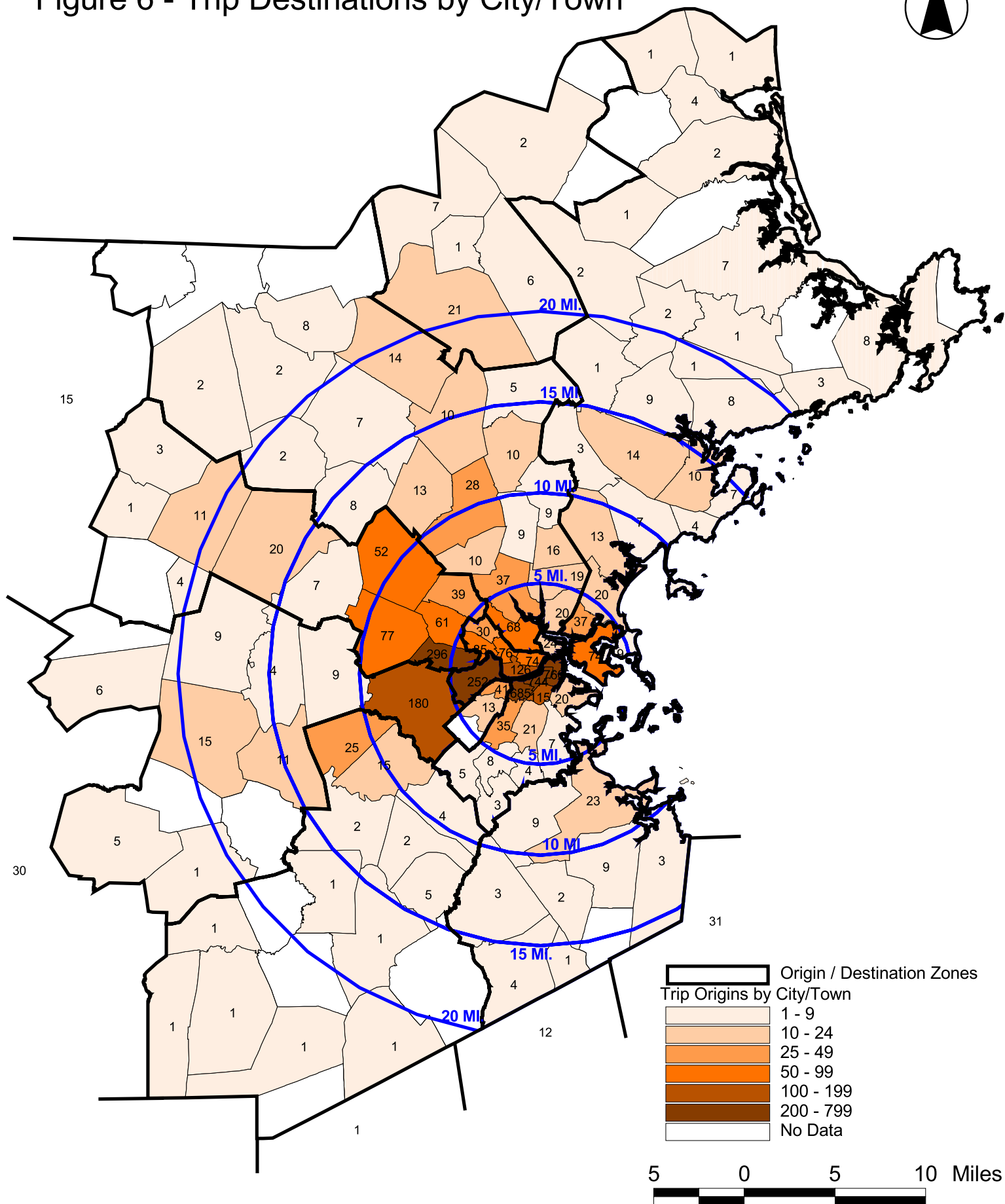


Figure 7
Question 3 - Trip Destination

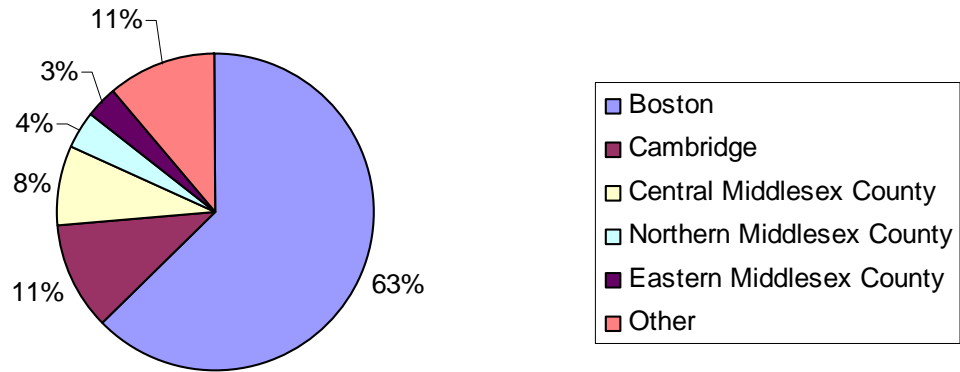


Figure 8
Trip Destinations within Boston

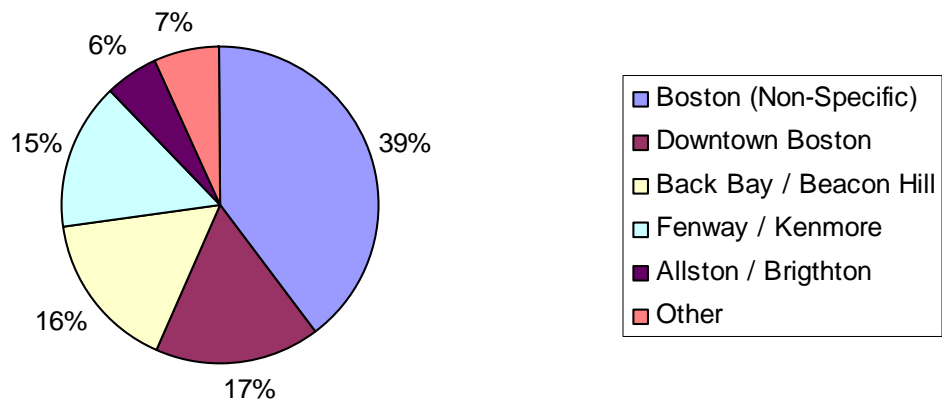


Table 2 - O-D Matrix

Question 5 - Where Did You Exit Storrow Drive?

Question 4 - Where Did You Enter Storrow Drive?



	Leverett Circle	Leverett Connector To I-93 North	Charles Circle	Arlington St.	Clarendon St / Copley Square	Mass Ave.	Charlesgate / Fenway	Boston University	Cambridge St. / Mass Turnpike	Western Ave.	North Harvard St.	Soldiers Field Road	Fresh Pond Parkway	Greenough Blvd.	Memorial Drive	Sum of All Exiting Trips	Sum of Feasible Exiting Trips
Leverett Circle	38	19	30	112	67	21	229	37	68	24	19	151	36	41	12	904	762
Leverett Connector From I-93	20	65	47	134	103	41	214	66	53	31	24	110	25	23	13	969	735
Charles Circle	35	33	14	15	9	1	39	5	36	6	6	56	33	7	7	302	241
Arlington St.	34	42	34	6	8	5	14	2	8	1	2	11	11	3	2	183	110
Berkeley St.	74	100	60	22	21	20	30	8	41	23	22	83	71	28	10	613	562
Charlesgate / Fenway	164	148	85	34	13	8	15	1	72	17	24	125	100	33	26	865	841
Boston University	77	89	41	23	18	6	7	3	13	2	3	7	10	0	9	308	255
Cambridge St. / Mass Turnpike	62	53	108	23	37	17	74	32	26	7	11	32	28	7	19	536	493
Western Ave.	17	21	19	7	17	3	20	8	13	4	3	35	17	13	5	202	195
North Harvard St.	10	12	14	17	11	3	26	9	13	6	6	13	12	3	4	159	150
Soldiers Field Road	116	74	138	92	99	15	146	54	66	31	14	23	11	4	15	898	860
Fresh Pond Parkway	71	32	89	78	107	14	164	73	59	9	8	4	12	0	2	722	696
Greenough Blvd.	31	13	32	31	24	3	53	20	10	7	3	0	0	3	2	232	226
Memorial Drive	11	15	15	17	19	9	40	13	13	3	1	16	4	2	4	182	169
Sum of All Exiting Trips	760	716	726	611	553	166	1,071	331	491	171	146	666	370	167	130	7,075	6,295
Sum of Feasible Exiting Trips	722	618	712	583	345	83	1,042	209	444	164	135	625	337	161	115	6,295	

No Response to Q4 or Q5: 22

Provided Exit Location only: 66

Provided Entrance Location Only: 107

Total: 7,270

 The Entrance Location = The Exit Location (Not Feasible)
 Travel Between the Entrance and the Exit is Not Feasible

- Question 6 – What other major roads were included in your trip? There were 367 unique roadways provided by 5,561 respondents. The most frequently reported roadways are presented in Figure 9. The most frequently reported highways are Interstate 93, Route 2, The Massachusetts Turnpike, and Route 1. The most frequently reported city streets are Beacon St, Commonwealth Ave, Massachusetts Ave, and Boylston St.
- Question 7 – What was the primary purpose of your trip? The results of this question are summarized in Figure 10. Work Commute was the largest reported purpose with 4,290 trips (59.0%). The next largest reported purpose was Business with 1,062 trips (14.6%).
- Question 8 – How frequently do you use Storow Drive? Figure 11 summarizes the results of this question. The largest proportion respondents reported that they use Storow Drive on a daily basis (4,865 trips, 66.9%). A significant number of respondents reported that they use Storow Drive on a weekly basis (1,756 trips, 24.2%).
- Question 9 – What other roads could you use to complete this trip if you could not use Storow Drive? There were a total of 268 unique roadways provided by 6,317 respondents. Memorial drive was the most frequently reported roadway with 2,974 occurrences. The next most frequently reported roadway was the Massachusetts Turnpike with 1,756 occurrences. Other roadways receiving a significant number of responses were Commonwealth Avenue, Interstate 93, Massachusetts Avenue, and Beacon St. The results of this question are summarized in Figure 12.
- Question 10 – Have you used public transportation to make this trip? 4,688 respondents (64.5%) reported that they have not used public transportation to make this trip, 2,545 (35.0%) respondents reported that they have used public transportation, and 37 (0.5%) did not respond to the question. The results are summarized in Figure 13.
- Question 11 – What bus routes, transit/rail lines, and stations have you or could you use if you could not use Storow Drive? Leading the list of transit possibilities were the Red Line (1943 responses) and the Green Line (1933 responses). Use of the subway system occurred 4,843 times, Bus use occurred 1,405 times, and Commuter Rail occurred 845 times. Up to 6 responses were recorded for each respondent. Figure 14 summarizes the responses to this question.

Figure 9
Question 6 - What other roads were included in this trip?
Top 25 Responses

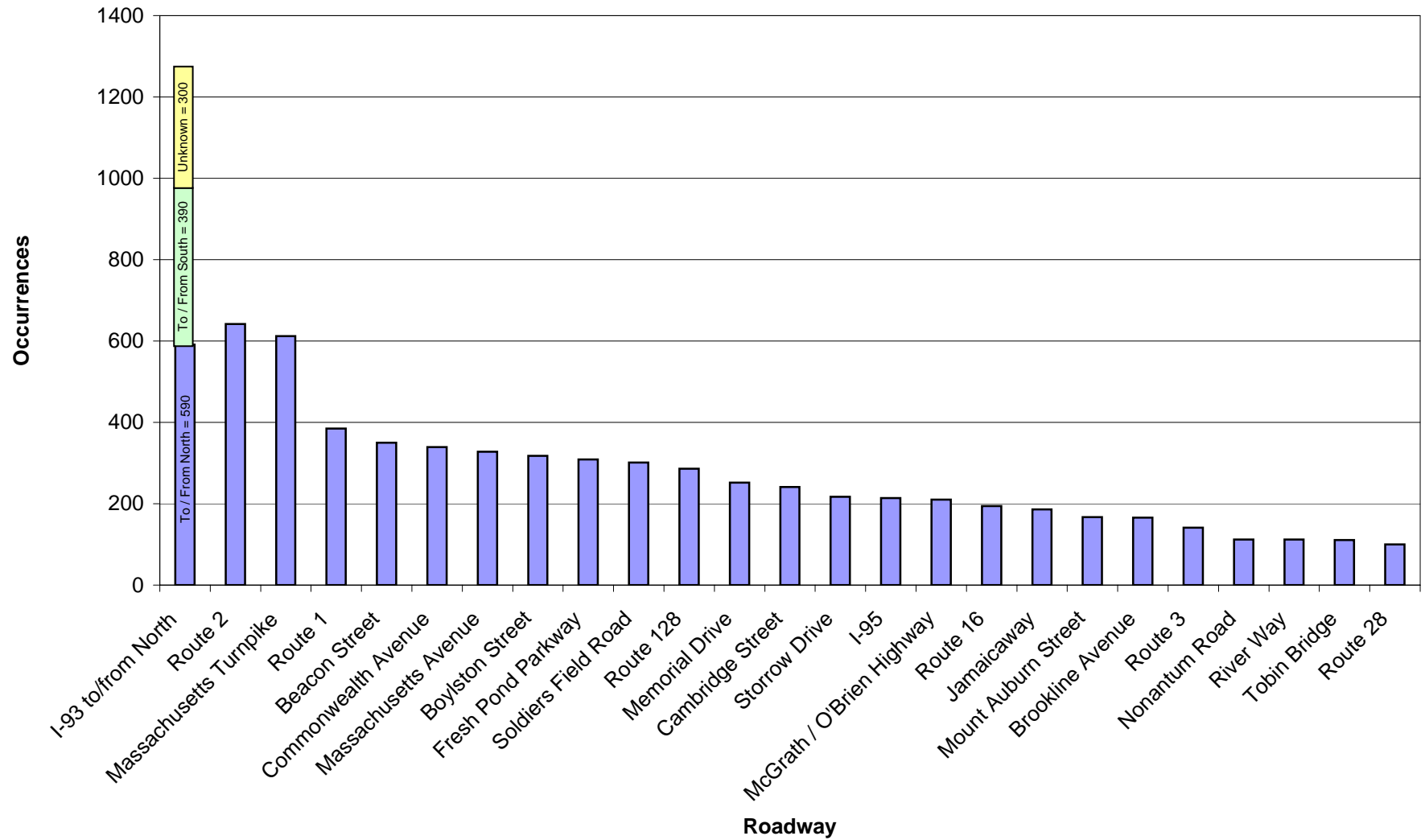


Figure 10
Trip Purpose

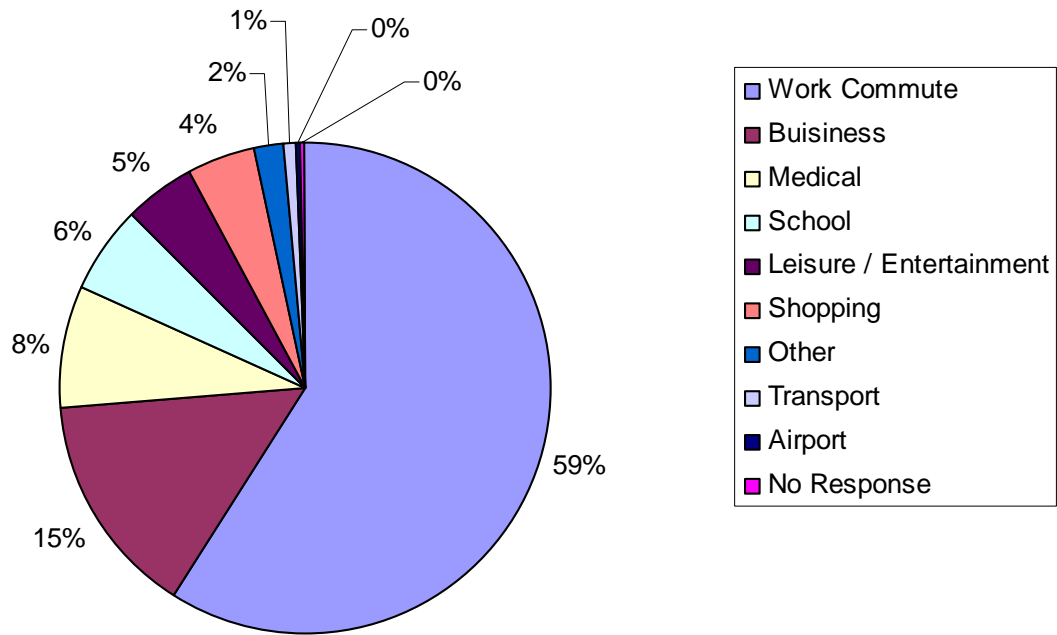


Figure 11
Trip Frequency

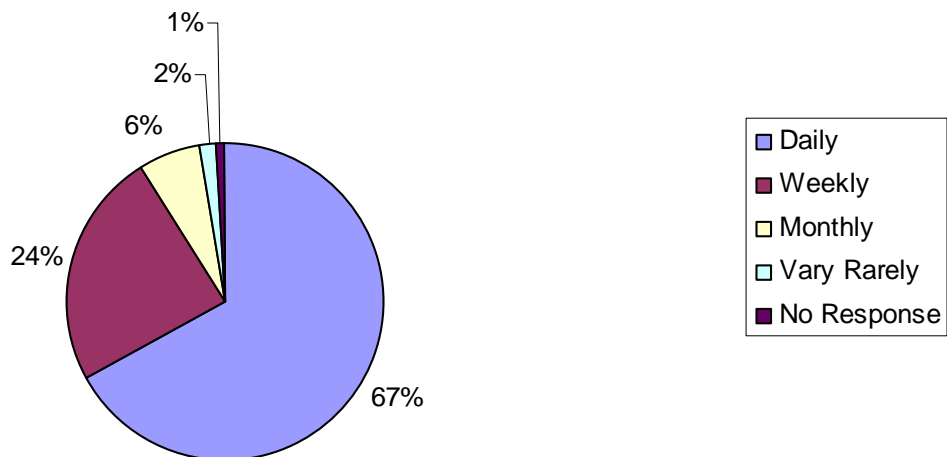
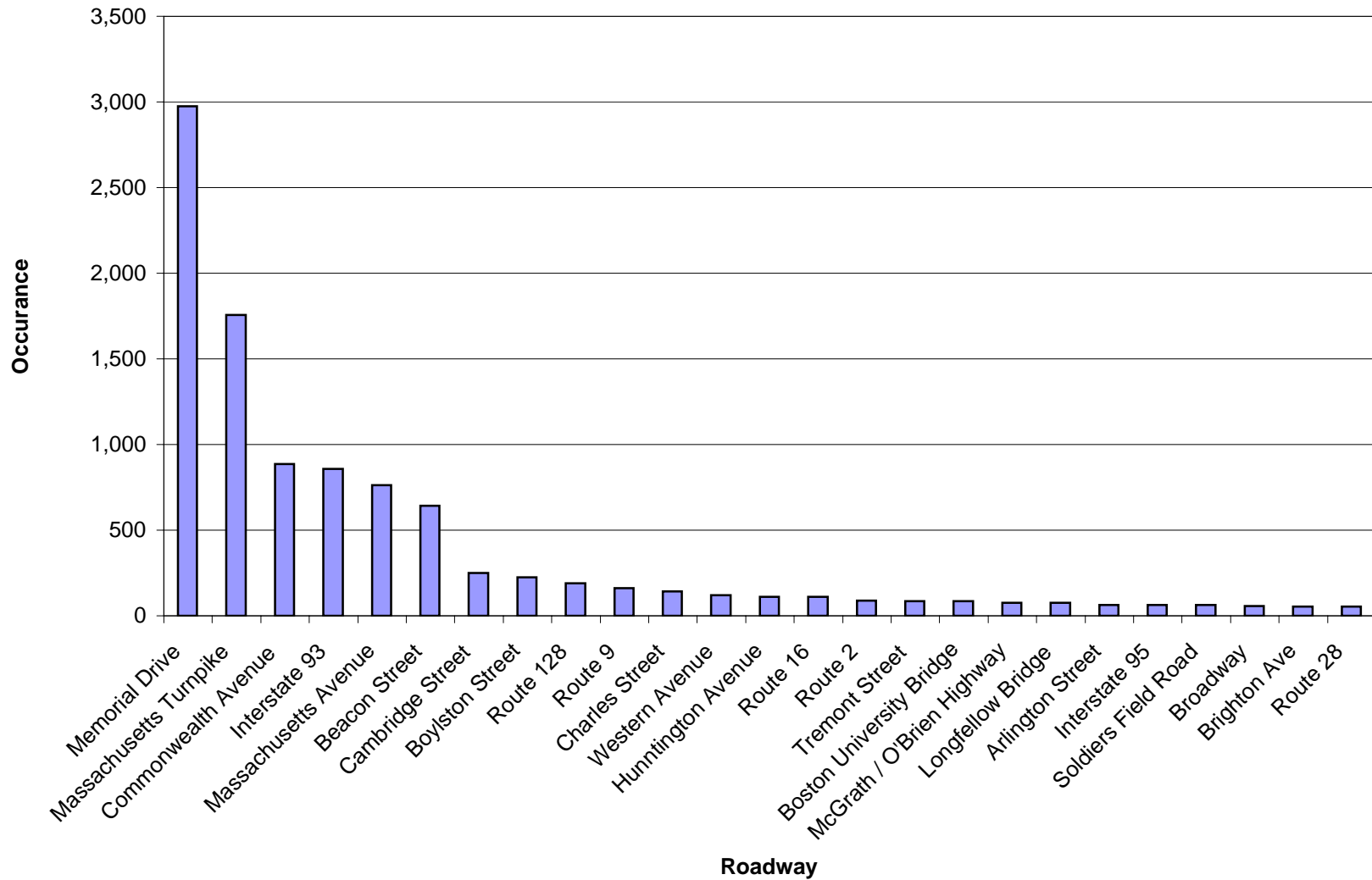
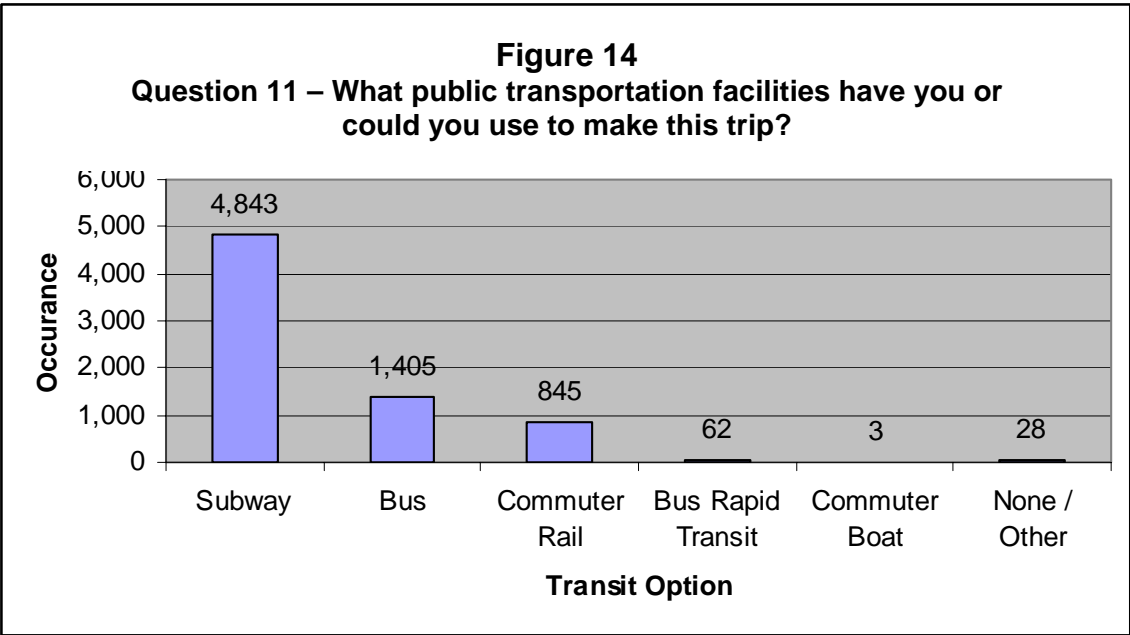
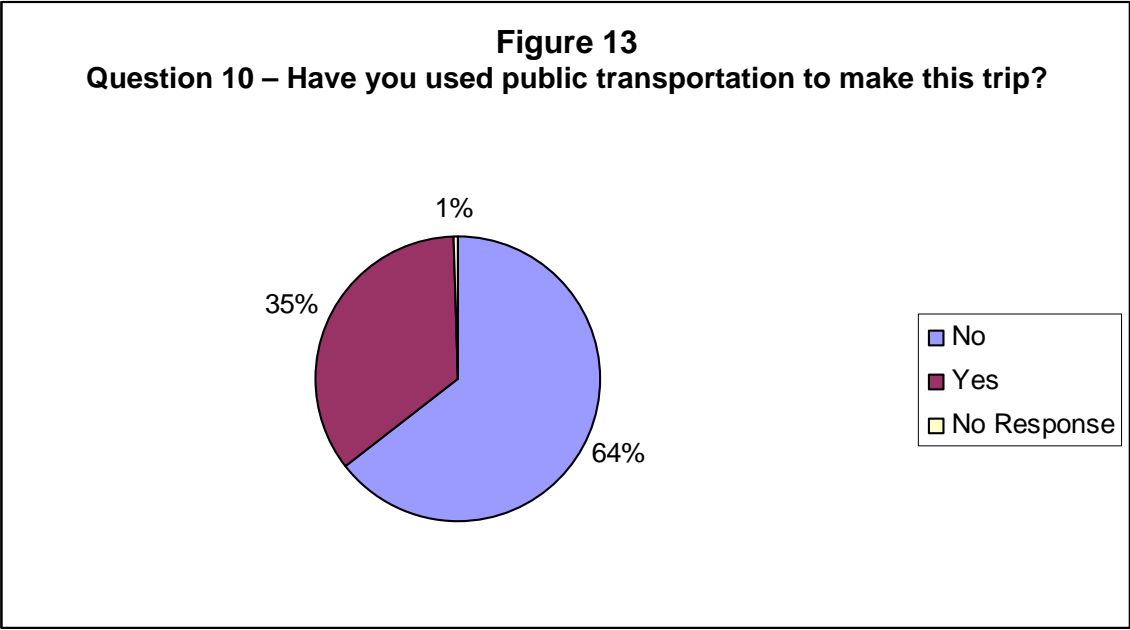


Figure 12
Question 9 - What other roads could you use if you could not use Storrow Drive?
Top 25 Responses





2. Origin / Destination results for various Storrow Drive Ramps

- Arlington Street On-ramp - The top four origin points for motorist entering Storrow Drive at the Arlington Street on-ramp are: Boston (Non-Specific Location), Downtown Boston, Back Bay/Beacon Hill, and The South End. The top four destination points for these motorists are: Boston (Non-Specific Location), Northern Middlesex County, Back Bay / Beacon Hill, and Downtown Boston.
- Berkeley Street On-ramp – The top four origin points for motorists entering Storrow Drive at the Berkeley Street On-ramp are: Back Bay / Beacon Hill, Boston (Non-Specific Location), The South End, and Downtown Boston. The top four destination points for motorists entering Storrow Drive at the Berkeley Street On-Ramp are: Boston (Non-Specific Location), Central Middlesex County, Cambridge, and Northern Middlesex County.
- Arlington Street Off-ramp – The top four origin points for motorist exiting Storrow Drive at the Arlington Street Off-ramp are: Northern Middlesex County, Central Middlesex County, Boston (Non-Specific Location), and North-East Essex County. The top four destination points for motorists exiting Storrow Drive at Arlington Street are: Back Bay/Beacon Hill, Boston (Non-Specific Location), Downtown Boston, and the South End of Boston.
- Clarendon Street Off-ramp - The top four origins for motorists exiting Storrow Drive at Clarendon Street are: Central Middlesex County, Northern Middlesex County, Boston (Non-Specific Location), and North-East Essex County. The top four destinations for motorists exiting Storrow Drive at Clarendon Street are: Back Bay / Beacon Hill, Boston (Non-Specific Location), the South End, and Fenway / Kenmore.

Findings

- The Data show that a majority of the trips that utilize Storrow Drive and originate outside of Boston are originating in either Middlesex or Essex Counties.
- A majority of the trips that utilize Storrow Drive are destined for Boston, particularly the Back Bay / Beacon Hill, South End, and Fenway / Kenmore areas of Boston.
- A majority of the motorists are arriving at Storrow Drive via I-93 from the north, The Massachusetts Turnpike from the west, Soldiers Field Road, and Route2/Fresh Pond Parkway.
- A large proportion of the traffic is commuting traffic that uses the roadway on a daily basis.

- The respondents have said that their alternate routes to Storrow Drive could include: Memorial Drive, Interstate 93, The Massachusetts Turnpike, Commonwealth Avenue, Massachusetts Avenue, Beacon Street, and Boylston Street.
- Primarily respondent said they have not used public transit to complete their trip. If they were to use public transportation they have indicated that they would use the subway system (particularly the Red and Green Lines), the bus system, and the commuter rail system. Most respondents indicated that they would be required to use multiple modes of public transportation to complete their trips.

Appendix A

Survey Form

The Department of Conservation and Recreation (DCR) has determined that the Storror Drive tunnels between Clarendon and Arlington Streets have deteriorated after 55 years of use, and are in need of repair. This work may result in partial and temporary shutdowns on Storror Drive. Your response to this questionnaire will help us plan traffic diversion strategies to minimize delay. All questionnaires **returned with a return address** will be entered in a drawing to be **one of five winners to each be awarded two box seats to a Boston Red Sox baseball game.**

The following questions refer to the trip you were making when you received this questionnaire:

1. Will this trip include Storror Drive? 1 ☐ Yes 2 ☐ No

If your answer to Question 1 is Yes, please continue with the survey.

If your answer to Question 1 is No, then please do not continue, and place this survey in the mail.

2. List the nearest major street intersection, City/Town, and State at which you **started** this trip.

Street Intersection/Landmark: _____

City/Town, State: _____

3. List the nearest major street intersection, City/Town, and State at which you **ended** this trip.

Street Intersection/Landmark: _____

City/Town, State: _____

4. Where did you **enter** Storror Drive? Please mark the option that best applies to you.

- | | | |
|--|---|--|
| 01 <input type="checkbox"/> Leverett Circle | 02 <input type="checkbox"/> Leverett Connector from I-93 | 03 <input type="checkbox"/> Charles Circle |
| 04 <input type="checkbox"/> Arlington Street | 05 <input type="checkbox"/> Berkeley Street | 06 <input type="checkbox"/> Charlesgate/Fenway |
| 07 <input type="checkbox"/> Boston University | 08 <input type="checkbox"/> Cambridge St. / Mass Turnpike | 09 <input type="checkbox"/> Western Ave. |
| 10 <input type="checkbox"/> North Harvard Street | 11 <input type="checkbox"/> Soldiers Field Road | 12 <input type="checkbox"/> Fresh Pond Parkway |
| 13 <input type="checkbox"/> Greenough Blvd. | 14 <input type="checkbox"/> Memorial Drive | |

5. Where did you **exit** Storror Drive? Please mark the option that best applies to you.

- | | | |
|--|--|---|
| 01 <input type="checkbox"/> Leverett Circle | 02 <input type="checkbox"/> Leverett Connector to I-93 North | 03 <input type="checkbox"/> Charles Circle |
| 04 <input type="checkbox"/> Arlington Street | 05 <input type="checkbox"/> Copley Square / Clarendon St. | 06 <input type="checkbox"/> Mass. Ave. |
| 07 <input type="checkbox"/> Charlesgate/Fenway | 08 <input type="checkbox"/> Boston University | 09 <input type="checkbox"/> Cambridge St. / Mass Turnpike |
| 10 <input type="checkbox"/> Western Ave. | 11 <input type="checkbox"/> North Harvard Street | 12 <input type="checkbox"/> Soldiers Field Road |
| 13 <input type="checkbox"/> Fresh Pond Parkway | 14 <input type="checkbox"/> Greenough Blvd. | 15 <input type="checkbox"/> Memorial Drive |

6. What other major roads were included in your trip?

7. What was the primary purpose of your trip? Please mark the option that best applies to you.

- | | | |
|---|-------------------------------------|--|
| 1 <input type="checkbox"/> Work Commute | 2 <input type="checkbox"/> Shopping | 3 <input type="checkbox"/> School |
| 4 <input type="checkbox"/> Medical | 5 <input type="checkbox"/> Business | 6 <input type="checkbox"/> Other _____ |

8. How frequently do you use Storror Drive? Please mark the option that best applies to you.

- | | | | |
|----------------------------------|-----------------------------------|------------------------------------|--|
| 1 <input type="checkbox"/> Daily | 2 <input type="checkbox"/> Weekly | 3 <input type="checkbox"/> Monthly | 4 <input type="checkbox"/> Very Rarely |
|----------------------------------|-----------------------------------|------------------------------------|--|

9. What major roads could you use to complete this trip if you could not use Storror Drive?

10. Have you used public transportation to make this trip? 1 ☐ Yes 2 ☐ No

11. What bus routes, transit/rail lines, and stations have you or could you use if you could not use Storror Drive?

Thank you for completing this survey. Please fold and seal this survey prior to mailing. Remember to include your **name and address** in the space provided on the opposite side of this survey in order to be entered in the drawing to be **one of five winners to each be awarded two box seats to a Boston Red Sox baseball game.** If you have suggestions on alternative modes of transportation or comments for the project team, please feel free to send an email to the following address:

info@reginavilla.com

**For Office
Use Only**

1 ☐

2-4 ☐

5-7 ☐

8-9 ☐

10-11 ☐

12-14 ☐

15-17 ☐

18-20 ☐

21-23 ☐

24-26 ☐

27 ☐

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29-31 ☐

32-34 ☐

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51-53 ☐

54-58

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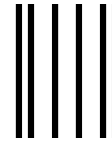
Align Bottom Edge Here

Align Bottom Edge Here

Re-fold survey and seal here.
Please do not staple.
THANK YOU.



Return Address:

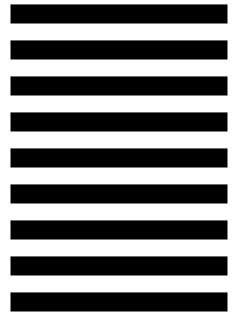


NO POSTAGE
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IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 78003 NORWOOD MA

POSTAGE WILL BE PAID BY ADDRESSEE



STORROW DRIVE IMPROVEMENT STUDY

C/O BETA GROUP, INC.
315 NORWOOD PARK S STE 7
NORWOOD, MA 02062-9978



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